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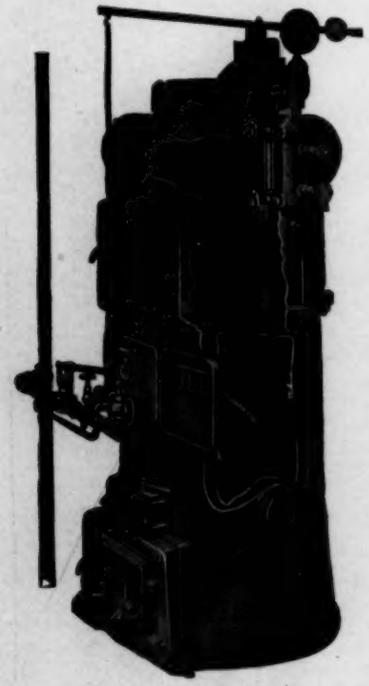

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American Gas Journal

SIXTY-SIXTH YEAR

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Distribution of Gas*

The principles and practice of distributing gas

Alfred Hulbert

Vice-President Equitable Gas Co., Pittsburgh, Pa.

IT is a great pleasure to talk to you men about the industry in which I have been privileged to spend the larger part of my life. During the past few years I have been associated with a public utility company that controls not only the gas business, but the electric and street railway business in our city, and I have been impressed by the occasionally expressed, and more frequently implied, feeling that the electrical industry is the only one of the public utilities that seems to be progressing. I feel it very important to impress upon you the fact that the gas industry is constantly growing, that it is today just as vital to the needs of mankind as any of our other utilities, and that there are many problems yet to be solved in this industry. These problems deal not only with lower costs of manufacturing and lower costs of distribution, but also entail a vast amount of research work upon the proper application of gaseous fuels to industrial uses.

The value of the gas manufactured annually in the United States has increased from less than $200,000,000 in 1910 to almost $500,000,000 in 1924, and there is invested in this business something in the neighborhood of one and one-half billion dollars.

The industry needs the assistance of the best minds in the country for aid in the solution of the many problems that constantly confront it, and I am delighted to know that the Johns Hopkins University is taking a forward step in the training of men for this need.

The distribution system of a gas company is generally considered to be that portion of its property which is devoted to transporting, storing and delivering gas to its customers from its source of supply, which source may be within the city limits or at the city gates if the supply comes from beyond the city.

*Presented before the School of Engineering, Johns Hopkins Univeristy, Baltimore, Maryland, April 1, 1925.

Distribution and Transportation

Where gas is carried for some distance, as is often the case of natural gas (which in many parts of the country is transported 200 miles or more) or where the manufactured gas is made at some central point and supplied to several towns or cities, that portion of the system carrying gas from its source to the city gates is referred to as the transmission or transportation system. The problems of distribution and transportation are so similar that they should be considered as one.

In general, when speaking of a distribution system, there is meant a net-work of pipe which delivers gas to a group of customers which may number from less than 100 in a small town to several hundred thousand, as in large cities. Thus the distribution system is the retail delivery department of a company.

Gas Burners and Pressures

Gas is the one product handled by the utilities that is not ready for use. When electric current is delivered, the customer turns a switch and has light; there is nothing the customer can do to alter the current which produces that light. The customer turns on a water faucet and obtains water, ready for use just as it is received. But when the customer turns on the cock at the gas appliance, he immediately mixes air with that gas, and must mix air with the gas before it is useful, though this fact is not generally appreciated by the consuming public.

Uniform Pressure Necessary for Good Service

Depending upon the quality of the gas, the amount of air that should be mixed will vary from about four parts of air in the case of gas of lower quality to as high as ten parts of air in the case of natural gas. The more nearly the mixture of air and gas is kept constant for any given gas the better is the

service obtained from that gas. Since almost all gas-burning appliances depend upon the injector principle, that is, they depend upon the force of the gas going through an orifice to entrain with it a certain amount of air, it becomes important to maintain the conditions under which this gas is delivered uniform. In order that the gas shall pass through the orifice at a constant rate, it is essential that the pressure of the gas remain constant. Therefore, when once there is fixed a pressure that is needed at a burner, it is necessary that this pressure be maintained. The maintainance of this constant pressure at the customer's appliances is the first fundamental problem in gas distribution.

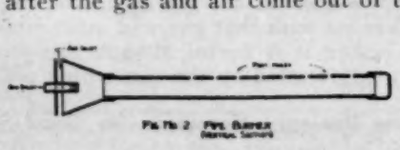
Standard Gas Pressures

Most of the modern household appliances, as well as a large portion of the industrial appliances, have been designed to work best on gas pressures of about 2½ to 3 inches water column; this is less than two ounces per square inch.

As all know, most gas burning appliances are based on the principle of the Bunsen burner, and I show herewith several burners of this type. Note that they have an adjustable air shutter. With constant pressure it is possible to entrain the requisite amount of air for the highest possible efficiency in the burner. After the shutter is adjusted the gas company must deliver gas at as nearly as possible constant pressure to this burner in order that the mixture of gas and air may remain constant. It is, of course, assumed that the gas company distributes a uniform quality of gas. This assumption is justified by the results obtained by most companies. All well-supervised companies keep careful hour to hour watch upon the quality of gas that is made in order to prevent variations in the quality of the delivered gas.

Gas Stove Burner

Figure No. 1 is a sketch of an ordinary gas stove range burner, and here it will be noted that the shutter is of a slightly different design, but the air openings are turned for adjustment in somewhat the same way in a simple design burner. However, an attempt is made in this burner to design the throat so that a better mixture is obtained than in the other two burners. It might perhaps be well to call attention to the fact that not all the air that is burned with the gas is pre-mixed with the gas before it reaches the flame. There is a certain amount of air mixed after the gas and air come out of the burner



Gas Stove Burner

portholes, and this burner has an opening for air up through the center to allow this secondary air to reach the flames. If a kettle is placed too close to the flames, a blackening effect results because there is not sufficient secondary air to permit complete combustion. Not enough oxygen reaches the flame to burn the gas completely to CO_2, therefore, the gas is burned to CO and some free carbon is deposited.

Importance of Pressure

Should the pressure of the gas be raised much above that for which the burner has been adjusted, the flame will leave the burner, sometimes burning above the burner, and frequently blowing out. This occurs because the rate of flame propagation is not as rapid as the speed of the gas. On the other hand, if the pressure be allowed to fall too low, the speed of the gas may be so slow that the flame will travel back through the burner and burn as a "flash back" at the orifice. In this second case carbon monoxide will surely be burned, because there is no primary air mixed with the gas and it is impossible for enough secondary air for complete combustion to pass through the primary orifices. Should the pressure of gas vary, it is necessary for the customer continually to adjust the burner valve or cock. Every time this is done conditions are changed in the burner, because the injecting action is altered, since there is no longer the same pressure at the orifice.

Pressure Regulation

In general there are two ways by which the pressures at the customers' houses may be kept uniform.

First, a pressure regulating device may be placed in every customer's house. In this case the pressure on the main system may vary within quite wide limits, but so long as the pressures are above that for which the regulator is set, the customer will receive a uniform pressure at his house.

Secondly, a regulating device, or a series of such devices, may be put on the city main, so that the pressures of the main system may be maintained uniform. In this way the customers' pressures will be kept within reasonable limits.

All distribution systems use either one or the other of these methods, but most of the large companies have a combination of both.

Importance of Costs

The fundamental reason for this use of both systems is one of cost. The young student of engineering should remember that almost any engineer can solve a problem, as there are usually a half dozen solutions to any engineering problem, but the best solution is that which gives the result desired at the least cost. In cost there must be considered not only the immediate investment, but also the cost of future maintenance, interest and depreciation. In some of the explanations of the distribution problems it will be necessary to call attention again to this fundamental principle.

Automatic Control of Gas Pressures

The governors or regulators which are used in the

(Continued on page 270)

Young Men and the Utility Business

Its main characteristics and its opportunities

Samuel Insull

IN attempting to answer the question asked in my theme, it may be helpful to point out some of the reasons why the public utility business is so attractive to me that, notwithstanding 46 years of service, I still work at it with the same enthusiasm as I did in the days of my youth. No doubt the young men who are coming into it today—and they are coming in shoals—feel much of the same lure that keeps me going.

If I had my life to live over again and as a youth could be endowed with the knowledge which experience alone gives, I would again go into the public utility business. I would do so not alone because of the recompense it affords, but because of the personal satisfaction that comes from participating in the solution of the great problems involved in semi-public business, so vital to the life and well being of the community, the state and the nation.

Many Problems to Be Mastered

Think of the problems yet to be mastered, and the policies and practices yet to be established, in making these already indispensable public utility services still more useful in this land of unlimited opportunity. There are problems to engage every kind of intellect and natural aptitude. There are problems essentially economic, political, financial and technical in character. These problems of management—of making the economic, political, financial and technical solutions do team work. There are problems of marshaling engineering talent to create facilities for service of utmost efficiency and economy in operation. There are problems of merchandising and selling that invite the best commercial ability available, for public utility service has to be merchandised and sold as dry goods, or shoes, or breakfast foods, or all other commodities, have to be merchandised and sold.

Individual Enterprise Should Not Be Fettered

Take this merchandising and selling question. Do not think the public utility industry's spectacular growth has been due entirely to the natural opportunities of a rich, free land, the spontaneous demand from the public for utility service. Just building an electric light or a gas plant or an electric railway or a telephone system does not make it a business.

The public utility business has had to be developed in the same way over every step of the road. The electric railway branch may seem an exception. Our natural laziness may prompt us to ride when we have the facilities, but intelligent merchandising and selling have a marked influence in swelling the number of riders. As for electric light and power, gas and telephone service, there is no satisfactory growth without finding new ways of making the services economically useful to more people, or usable in more ways by the same people, and then "selling" them the advantages of use and the ways and means of employing those advantages.

Political Ownership Unsound

If we Americans ever put restrictions upon individual ambition and enterprise by adopting governmental or political ownership, then we shall have necessarily a government far different from this that has fostered our wonderful development, and consequently we shall have a far different country to live in. Political ownership once seriously undertaken in any industry will soon extend to the factory and the farm; it will become political ownership of all business and industry, including the colleges and universities and newspapers that play with the idea.

Municipal and kindred political ownership proposals are not new, and their failure to make more headway in this country has not been due to sinister opposition from the so-called "capitalistic interests," as alleged by the soapbox orators. It has been due to their impracticability and their inherent economic unsoundness.

Capital Requirements an Index of Growth

It may seem that, in the foregoing, I have strayed from my subject. But what has just been said bears a close relation to your business and professional future. It will be of great assistance to you to know your country and its institutions and its social and economic structure, not academically but practically—to know how and why things happen as they do in government and in business—to know the practical reasons why theory does not always work out when it bumps against human nature and habit and established practice. If this leads you to take an interest in public affairs, not to "go into politics" necessarily, but to be concerned to discharge all your obligations of citizenship, so much the better. One who is an active citizen in the community where he lives is by so much a better business or professional man.

Let us turn now to another indication of the practical and material opportunities in the public utility industry. Take the new capital requirements in various well-known lines of business: New capital requirements are an index to growth and expansion. That is what new capital is needed for—to extend the business by additions to plant and equipment, or

(Continued on page 273)

*Abstracted from an address to the students of the University of Illinois, Urbana, Ill.

Regulating Thermal Value of Gas

A description of a useful auxiliary apparatus

C. Deschamps

(The following paper, which was read before a meeting of the Societe Technique in France and which is taken from the French journal, La Genie Civil, describes an apparatus and method which were used for a number of years for the purpose of controlling the quality of gas manufactured in a French gas works. The apparatus was made in the form of a calorimeter and it is interesting to note that very good results were obtained with this, what might be called home-built device. Control of the calorific power of gas is an important matter everywhere today, and the American gas man will be interested to read of how this instrument was made and of the results that were secured with it.—Trans.)

THE apparatus which is herein described was used a number of years in a French gas works. It was found it was possible to tell the calorific power or thermal value of the gas at any moment by glancing at the apparatus and the accuracy of the determination was commensurate with the purpose for which the device was employed. In fact, the apparatus must be called a "carburimeter," rather than a calorimeter, but it is possible easily to convert the readings on the carburimeter into caloric readings, and the error which is involved in the process is not sufficient to negate the value of the results obtained.

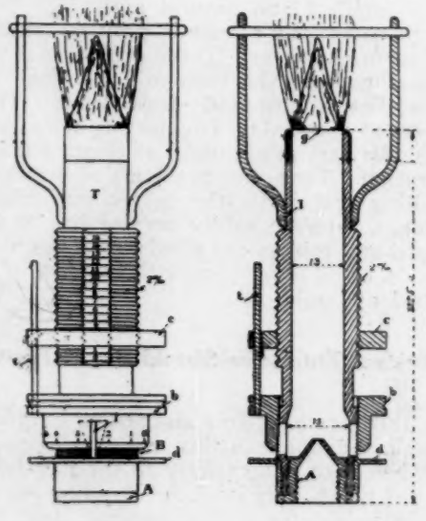
Form of the Apparatus

The apparatus is made in the form of a burner. It consists in essential of an injector which has a single opening. In the figure this injector is seen at A. The injector orifice opens up into a mixing chamber, B, and to it there is connected a tube, T, which extends up along the side of the injection for a certain distance. The injector is also provided with a screw, which is marked off in divisions so that its position may be indicated at any time.

The air inlets which lead into the mixing chamber, B, are made in special form. The purpose has been to make the instrument extremely sensitive, so that no matter what might be the quality of the gas that is introduced into it sufficient air will be admixed with the gas so that it burns properly and completely. The ring, b, regulates the size of the orifice, and this ring can be turned, being threaded and turning on a screw with a half millimeter thread. The top of the tube, T, is closed with a piece of wire gauze, g. Then, as may be seen from the figure, a rod, which is made of magnesia, is properly supported and held above the wire gauze at a distance of approximately 25 millimeters. When the gas burns in the tube, this rod will then be at a definite point in the flame. This is, as shown, just at the apex of the inner bluish cone.

Further Details of the Apparatus

The screw thread, as has been mentioned above, has been selected very fine so that the regulation of the air supply to the burner is carried out as accurately and sharply as possible. The regulation is easy to effect and can be readily observed by counting the number of thread turns of the ring, b, above its original position. Thus, in the figure this will be seen to be 4 thread turns. It will be seen from the figure that the ring, b, is connected with a disc, C, which turns on a two millimeter thread into the tube, T. Every turn of the ring, b, is accompanied by a corresponding movement of the disc, C, the connection between the two rings being effected by means of the rod, t. The threads on the tube, T, are marked off in suitable manner and there are also 10 divisions marked off on the ring, C, which means that the amount of turn of the ring, b, can be recorded in tenths of a division of the thread on the



tube, T. The magnitude of the movement of the ring, b, is measured from the pointer, I.

Using the Instrument

It is stated that in the use of the instrument—and it may be employed as an indicator, "carburimeter" or calorimeter—the same pressure should be em-

(Continued on page 272)

GAS MERCHANDISING

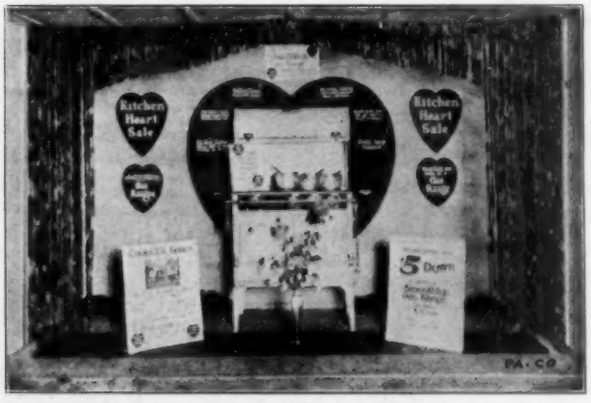
Domestic – Industrial

Ideas for the Man Who Sells

William H. Matlack

PASSING ON GOOD IDEAS AN INNOVATION FROM THE PACIFIC COAST

THE window display shown here comes from the Pacific Power & Light Co., operating gas properties at Astoria, and Pendelton, Oregon, Walla Walla, and Yakima, Washington, and Lewiston, Idaho, and we learn from The Vulcan Bulletin that this company gets up window displays in Portland, has them photographed and sends the photographs to each of their district commercial managers for reproduction. This is an economical way

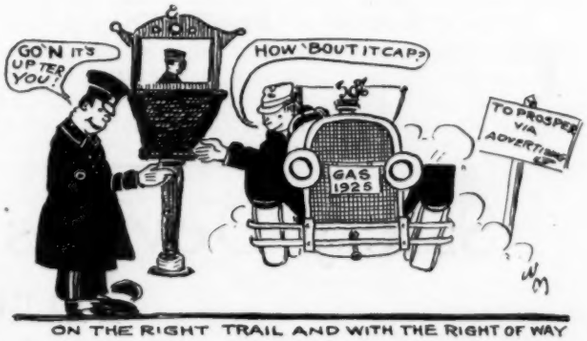


to help the other fellow and it cannot be doubted but what the men in charge of the company's various divisions are glad to have this detail taken off their shoulders.

It has been the idea of The American Gas Journal to reproduce attractive window displays in the Merchandising Section now and then to help the man here and there who has charge of the window trimming. We also have suggested backgrounds and, and the other day a man who has devised some very clever windows told us that he has a scrap book full of "window ideas," many of which came from this department.

RED TAG SALE

THE Illinois Power & Light Corporation has taken another idea on to sell gas appliances that should move this type of merchandise. The I. P. & L. are using the furniture man's tag



sale. Tags of red have been attached to all appliances and hence the sale is a Red Tag Sale. The special inducement to prospective customers is a $2 down payment and 12 months in which to pay the balance of the purchase price.

SHE ALWAYS SELLS THEM

A GREAT many gas companies now employ young women for floor sales. Young women, who are able to establish personal contact with the rank and file of customers, who make bill

paying a pleasure and an occasion of visiting, when such topics as "How is the baby?" and "We have a new recipe for a wonderful salad," who also possess that quality of sympathy and understanding that exists only between women, bring the purchasing agent for the home into the gas company's store more regularly. And, too, she never fails to see the new appliances, ranges, water heaters and kitchen equipment. She learns that Mrs. Brown has just purchased a new gas range with oven heat control, that the Joneses are having a gas-fired boiler installed in their new home and that Mrs. Green has ordered one of "those beautiful gas fires, that cost $95."

Thus, because the floor saleswoman has remembered facts and details, the "purchasing agent" has learned and she now yearns for the things other

home managers have and she will have them, too, in time. The saleswoman who is cordial to all and who remembers details and is able to adapt herself to the various types of customers is making the gas company's store a popular shopping center in many cities.

On the other hand, the indifferent, disinterested sales person is very quickly spotted by the home manager and the stores wherein she or he is found are given a wide berth.

SEE THAT THE DOMESTIC SCIENCE EXPERT USES THE KIND OF RANGE YOU SELL

THE gas man who doesn't see to it that the Domestic Science Teachers in his territory uses the make of ranges he sells is overlooking a mighty big sales opportunity. Many, many women are interested in what the expert has to say regarding the preparation of meals, special dishes, the working out of balanced menus, etc., etc. And while they take these lessons to heart and try the recipes that the domestic science expert furnishes them, back in their hearts they usually feel and frequently say to themselves: "I know I could do just as good as she does if I had one of those ——— gas ranges like she uses." Right then and there is born the desire to have "one just like that domestic science teacher used." You, who read Mrs. S. R. Dull's page in the Atlanta papers, don't need to be told what range she uses, for you have seen the name of it on the door in countless pictures, nor do those of you who read Mrs. Margaret Forbes' articles in the Indianapolis Star need to be told what ranges she uses. It is safe to say that the domestic science teachers in the schools of both these cities have visited these well-known experts to see just what kind of ranges they used and have gone forth to recommend them.

Safety Devices for Tank Water Heaters*

Importance of use of thermostats and relief valves

Frank A. Woodhead
Arlington Gas Light Co.

IT is difficult to cover this topic completely in a small space and yet it may be discussed briefly under the following three headings:

1. Why are safety devices necessary on water tank heaters?
2. What devices may be used?
3. Where shall they be located?

Why Are Safety Devices Necessary on Tank Water Heaters?

Three things happen when water is heated for domestic purposes by fuels such as coal and gas, burned in their respective appliances:

1. The temperature of the water increases in proportion to the amount and the rate of the heat applied.
2. The water increases in volume in proportion to the heat applied.
3. The pressure increases according to how the temperature increases, if the water is confined.

When the temperature of the water increases to such a point as to create danger, we say that the water has been over-heated.

The volume of the water increases because the water expands when heated.

The pressure increases because of the increase of volume.

When a tank water heater is installed on a so-called open system, that is, where there is a tank installed in the attic, there is not the danger in connection with over-heating the water that there is when the tank water heater is connected to a direct pressure system, that is, where the pressure comes directly from the street.

Open System Tank Heater

In the installation where the open system is in use and the water becomes over-heated, the open tank in the attic serves as a relief or safety valve and the greatest damage that might result would be the effect of the vapor or steam arising from the hot water in the open tank to the adjacent woodwork or plastering. Moreover, it is not every direct pressure job that becomes dangerous by the installation of a tank water heater, unless the piping system becomes sealed by the means of a check valve in the supply line or in the event that a shut-off cock would seal the supply pipe. Check valves are ordinarily placed in the supply line to prevent hot water from the boiler reaching the water meter and ruining the rubber disc used in the meter.

While it is, therefore, essential that some means be taken in every case to prevent domestic water from being over-heated, yet it is absolutely necessary to make provisions in the installation for the prevention of over-heating of water in the so-called sealed, closed or direct pressure system.

(Continued on page 275)

*From "Service Talks."

As The Journal Views It

THE CONVENTION DAILIES

This year marks the fourth consecutive time that the American Gas Journal will publish a set of Convention Dailies, one for each day of the Convention that is to be held this October in Atlantic City. The first daily issues of the American Gas Journal were published four years ago, in 1922, and were in the manner of an experiment. The reception that the gas industry of the country gave the 1922 dailies encouraged the American Gas Journal to issue them again in 1923. The Dailies were also published in 1924 and the American Gas Journal Dailies have now become one of the features of the Convention of the American Gas Association.

The 1922 Dailies were four in number, being issued on Tuesday, Wednesday, Thursday and Friday of the week. The next year the number of the Dailies was increased to five, the first Daily appearing on Monday. This practice has since been followed in the successive years of the Dailies.

It will be remembered that the topic selected for treatment in the first Convention Daily in 1923 was the history of the American Gas Association and the associations that preceded it, as well as the various State and District associations that are affiliated with the American Gas Association. In the 1924 First Daily there was published a complete and comprehensive story of gas from the earliest time to the present.

For the first Convention issue of the 1925 Dailies there has been prepared, under the direction of the Editor of the Journal, a story in the nature of a symposium on various problems and movements that are taking place today in the gas industry. A number of gas men, prominent in their various fields of endeavor, were invited to take part in this symposium. And the reception that has been given to this plan has been very gratifying, indeed. The story will contain statements from a number of well-known gas men, telling of their views on the important matters that are agitating the minds of the leaders of the industry today, and of the effect of these various movements and developments that are now taking place in the gas industry on the future progress of gas in its use as a domestic and industrial field.

The Editor wishes to take this opportunity to thank these men and women for the interest that they have shown in this symposium. The statements that he has received have been more than gratifying, and have exceeded his fondest hopes of success. The interest that these gas men have shown indicates very clearly, indeed, that the gas industry is composed of men and women to whom gas affairs are of such importance that they are willing, not only to give the best of their ability to their work during the course of the day, but also to spend at times their leisure moments in preparing articles and statements for publication so that their fellows in the industry may benefit in one way or another from their experience, study and investigation of gas problems.

Gas men are today keenly alive to the fact that their industry is in a state of development, and that the direction that the future progress of the industry will take depends very largely on the impetus that is now given the industry along a definite direction. Just what that direction will be is still a matter of discussion and study. This is essentially an era of formation. Now is the time when the utmost care must be taken to see that our industry is properly directed in the path of future progress. It, therefore, behooves every gas man to give as much as possible of his time to the study and discussion of important movements in the gas industry.

This has been the prime purpose of preparing the symposium which will be printed in the first Convention Daily of the American Gas Journal. In it there will be contained a great variety of opinions and statements regarding the future development of the gas industry, and the important problems that gas men have to solve, in order that ultimate success may be attained. It is recommended that every gas man, whether he stays at home or attends the Convention, give particular attention to this story. For in it he will find much of interest and importance which will be to his advantage both to understand and to be able to discuss intelligently when meeting with his fellow gas men.

The Educational Needs of the Gas Industry *

The various methods now employed are discussed

C. A. Luckenbach

Los Angeles Gas & Electric Corporation

THE objectives of the Educational Bureau this year were to make a survey of the universities and schools of higher education on the Pacific Coast, to make a study of their facilities and curricula, and to obtain the viewpoint of educational leaders. With these data we hoped to be able to formulate a definite educational policy which would meet the needs of the gas industry and which would, in addition, follow closely the trend of modern educational methods and so secure the approval and cooperation of professional educators.

While this program has been only imperfectly carried out, we believe that sufficient data has been secured upon which to base a general recommendation for the approval of the association.

The gas industry must face the fact that it is a competitive business, and that its future depends upon its supplying a fuel which is economically and physically superior to all others. This means that we shall have to continually study and adjust our gasification processes to meet changing conditions, that our business will at all times have to be soundly financed and wisely managed, and that we shall be obliged to develop salesmen who know fuel and its utilization. The accomplishment of these things depends upon men, and there is nothing fundamentally more important for the association to do than to develop means to assure to the gas industry its share of trained and intelligent young men.

University authorities are constantly being asked to install courses applicable to specialized industries and to comply with all such requests would require a great number of elective courses, with attendant equipment and instructors, in most of which not one student in a hundred would be interested.

Purpose of Education

Those who are concerned with education are coming to realize that its primary purpose is to train our young people for life and citizenship, and to instill ideals which make for leadership in its broadest sense. Educational institutions are becoming more and more concerned with providing this broad fundamental training, and it follows that in the brief four years usually allotted, the specific technical and professional courses are necessarily being crowded out of curricula. This tendency has reached its most advanced stage in the preparation for the professions of law and medicine, three years' general education being required by most schools before the student can start his professional studies.

Nearly every educator with which we have been in contact holds this view and we are constrained to believe it is correct and scientific. In view of this condition, we suggest that the educational activities of the association should be developed along the three following lines:

(1) Imparting interest in fuel technology and public utility management to university and technical school students.

(2) Fostering and urging the installation of facilities for and instruction in fuel technology and public utility management available to graduate students whose interest has been aroused.

(3 Fostering and urging specific professional instruction for men already employed in the gas industry.

Imparting Interest

The gas industry wants the same class of young men the universities wish to turn out—young men thoroughly trained in fundamentals, accustomed to think and study and imbued with initiative. If, in addition, students of this type can be interested in the problems of the gas industry, a pressure would be created from within and in time facilities and courses of study would be provided. Even without these, the interested students would apply to us for information which we should be in a position to supply.

As a means of maintaining the contact which will create this interest and keep it alive, we suggest that a permanent committee be appointed composed of an executive of each gas company having an institution of higher education in its territory, and that the secretary serve as its chairman. The duties of the committee would be to establish close contact with the school authorities, study their curricula, provide books and pamphlets to the libraries and to individual instructors and students, urge the use of gas for fuel purposes in the shops where students are instructed in manual arts arrange for lectures before classes and student organizations, arrange for trips through gas plants and offices, and attempt to find both seasonal and permanent employment for students whose interest has been aroused.

The selection of research problems dealing with the use of gas for bachelor's and master's theses should be encouraged. It would be feasible for the association to offer a prize for the best thesis each year and to include as a part of our proceedings all these which are of merit.

(Continued on page 268)

*Delivered as the report of the Educational Bureau at the Pacific Coast Gas Association Annual Convention.

INDUSTRIAL GAS LESSONS

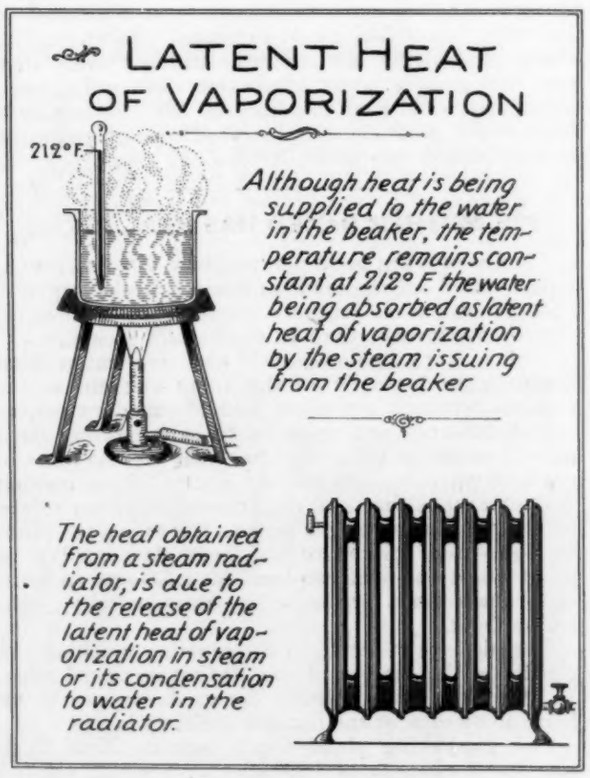
IF IT'S DONE WITH HEAT — YOU CAN DO IT BETTER WITH GAS

Lesson No. 89

Heat and Change of State

HEAT OF VAPORIZATION

THE next subject to be discussed under the general head of the change of state is the heat of vaporization. It has been mentioned before that when the temperature of a liquid is raised to the boiling point and heat is continually supplied to that liquid at this temperature, the substance will undergo a change in state. It will be converted into a gas or vapor. The heat that must be supplied to accomplish this transformation per unit weight of the liquid is called the heat of vaporization. It is also called latent heat, just as the heat of fusion is designated latent heat of fusion, for the heat is hidden, that is, no temperature rise accompanies absorption of this heat by the heat body. It apparently disappears, but is in reality contained for the time being in the substance in the gaseous condition. This heat is released when the vapor condenses and forms a liquid.


LATENT HEAT OF VAPORIZATION
212° F.
Although heat is being supplied to the water in the beaker, the temperature remains constant at 212° F. the water being absorbed as latent heat of vaporization by the steam issuing from the beaker
The heat obtained from a steam radiator, is due to the release of the latent heat of vaporization in steam or its condensation to water in the radiator.

Latent heat of vaporization is an important matter and use is made of it in a practical way more commonly than the latent heat of fusion. Steam heating of houses and factories depends on the fact that steam contains latent heat of vaporization, which heat is released by condensation in radiators. The heat that is contained in the steam even at a low pressure is considerable, for the simple reason that by far the greatest part of it is latent heat.

Each Liquid Possesses Own Latent Heat

Each liquid has its own latent heat of vaporization and this is as much a characteristic property of the liquid as the boiling point or color. The following tables give the latent heat of vaporization of various important liquids. Latent heat is expressed not only in British thermal units per pound, but also in calories per gram and in kilogram calories per kilogram. The conversion factor for changing calories per gram into British thermal units per pound is ?, which means that the calories per kilogram must be multiplied by this factor in order to obtain British thermal units per pound.

Table of Heat of Vaporization

Substances	Calories per kg.	B.t.u. per lb.	° C.	° F.
Ammonia	294.21	530	7.8	4.6
Acetic acid	84.9	217.26	118	..
Air	44.02	79.3	..	..
Amyl alcohol	120	..	131	..
Alcohol, grain	205	376.05	78.1	..
Alcohol, wood	267.48	482	64.5	148
Arsenious chloride	..	95.4	..	..
Acetone	139.9	..	0	..
Alcoh. plus 5% water	214.25	386	78.4	173.1
Bromine	45.6	82.80	61	..
Benzene	109	196	0	32

Carbone dioxide	56.25	103.3	0	32
Carbon disulphide ..	89.5	156	0	..
Carbon tetrachloride.	51.9	..	0	..
Chloroform	67	..	0	..
Decane	60.83	109.5	159.45	319
Ether	88.4	163.80	34.5	..
Ethyl acetate	..	190.44	..	..
Ethyl bromide	..	101.97	..	..
Ethyl chloride	..	160.47	..	..
Tthyl formiate	..	189.54	..	..
Iodine	..	5.31	..	..
Mercury	65	111.60	357	..
Methyl acetate	..	198.36	..	..
Methyl formate	..	210.78	..	..
Nitrogen	49.83	89.6	..	..
Nitric anhydride	..	80.65	..	..
Nitrous oxide	..	181.08	..	..
Phosphorus trichloride	..	92.55	..	..
Sulphur	..	651.60	..	..
Sulphur dioxide	91.2	170.20	0	..
Sulphur trioxide	..	264.69	..	..
Stannic chloride	..	54.95	..	..
Turpentine	74.04	..	159.3	..
Water	535.9	964.6	100	212

THE EDUCATIONAL NEEDS OF THE GAS INDUSTRY

(Continued from page 266)

Graduate Courses

There is already in existence a graduate course in gas engineering at the Massachusetts Institute of Technology, and a course leading to a degree in gas engineering has been founded at John Hopkins by the Southern Gas Association. A few other eastern schools have specific gas engineering courses as part of their mechanical and chemical engineering work. Nothing of this kind exists on the Pacific Coast. It would be of considerable advantage to the coast gas industry if one school were to install the necessary equipment for giving instruction in gas engineering. The equipment, the trained instructors, and the students taking the course would also be of aid in research work which will be desirable from time to time. It is unlikely that we can for some time give fitting employment to more engineers than one such graduate course would turn out, so our efforts in this regard would best be concentrated on one institution. The success of such a course would be dependent upon the interest we are able to create among students, and its initial installation will also be dependent upon this interest, together with some measure of financial support.

Instruction of Employed Men

Theer can be little doubt that our most fertile field of educational endeavor lies with the men already employed by our companies. Not only is our responsibility greatest to them, but in them interest has already been created and this interest is coupled with the incentive to improve their position in their chosen field. There are many ways in which educational opportunities can be offered and in some of these the universities can co-operate.

There are several eastern and middle western institutions which, with the co-operation of gas companies and associations, offer each year a two weeks' course in the care of meters. The University of Pennsylvania offers an evening course in business economics and the regulation and operation of public utilities. Regular university credits are given to those completing the course, which extends over a year's period. There is nothing similar to this course offered on the Pacific Coast, although the extension divisions of our universities cover the same ground in a multiplicity of courses which could easily be assembled if the demand warranted.

Evening Classes Conducted by Companies

A number of our companies offer direct educational advantages to employees through evening classes conducted by qualified department heads. This practice can, of course, only be possible in a large organization, but a way might be devised through the association to spread the course of a large company to the employees of smaller companies near by, either by correspondence or direct attendance.

Correspondence courses conducted by associations do not appear to be feasible, largely because they must be conducted as a side issue. The correspondence course starting this fall and given by Columbia University under the auspices of the American Gas Association, has more chance of success because of its being conducted by professional educators. As there is probably not sufficient call for more than one such course, your committee does not recommend any activity of this kind on the Pacific Coast. Our efforts should be concentrated on supplementing it with instruction which it does not give.

PIE MOTHER BAKED HAS REAL RIVAL

Time was when good pie, properly filled and well-baked, could only be made at home, with loving care. "Store" pies were leathery circles better suited to the discus-thrower than to the human stomach.

Today more "home-made" pies are eaten than could be produced by all the home kitchens in the country working overtime, and the modern pie, as served in hotels and restaurants, is apparently liked as well as the pie that "mother used to make."

Given good ingredients, the secret of pie-making is in careful baking, and the problem has been solved by the application of gas heat to the industry. Modern gas-fired equipment has been developed to a point where one oven can turn out 1,200 pies an hour, each one cooked precisely by automatically controlled heat.

The pies are taken from the crusting machine and placed on the shelves of the 30-foot gas-fired oven. In this they travel slowly forward for nearly an hour, to emerge at the far end perfectly baked.

One pie-baking plant which supplies New York City has a capacity of 4,000 pies an hour, all cooked by gas. This plant alone could produce enough pies to serve a slice a day to 600,000 persons, and it is but one of a number required to meet the city's pie-hunger.

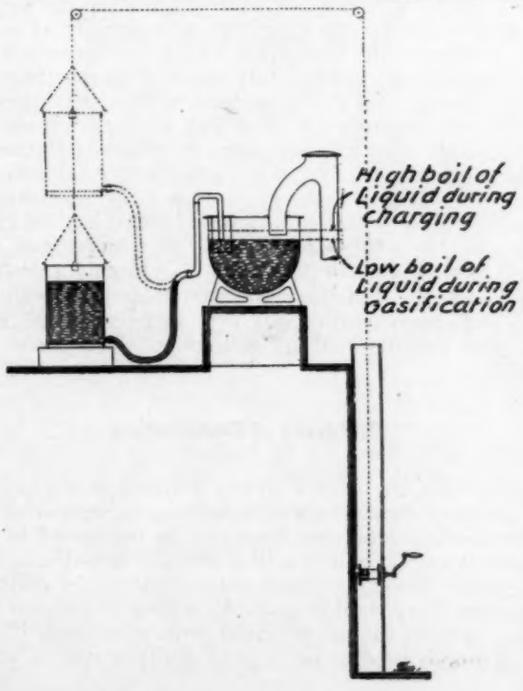
PROGRESS IN GAS TECHNOLOGY
Domestic and Foreign

NEW METHODS OF GAS WASHING

THE essentials of a good absorbent are low volatility, high absorptic capacity, and rapid solution of vapor to be absorbed. Similarity of chemical constitution between vapor and absorbent also exerts a favorable influence. Tetrahydronaphthalene, being intermediate in structure between the aromatic and aliphatic hydrocarbons, possesses all the qualities of a good absorbent for both aromatic (benzene) and aliphatic (benzine) hydrocarbons. In the case of benzene the addition of small amounts of naphthalene to the absorbent at first increased and then decreased the absorption. In the case of the aliphatic (benzine) hydrocarbons, the saturation capacity of tetrahydronaphthalene was greatest for the hydrocarbons of highest density. Fairly good absorption was also obtained for carbon disulphide vapor. Experiments show that tetrahydronaphthalene is an excellent medium for the recovery of volatile hydrocarbon vapors, and the results have been confirmed in practice.—(Z. angew Chem., 1925, 38, 359—362.)

NEW ARRANGEMENT OF HYDRAULIC MAIN

THE accompanying photograph shows a new arrangement of hydraulic main, which consists of a vessel whose vertical position can be adjusted and which is arranged near the main over the top of the retort installation. The feature of this new system lies in the fact that the connection between the vessel and the tar receiver enables an interchange of the liquid between the receiver and the aforementioned vessel, according to the principle of the syphon. The connection consists of a fixed gas pipe in the form of an inverted U. The shorter end of this pipe dips into a box that is built into the vessel. The longer end, on the other hand, is connected by means of a wire-protected rubber hose with the vessel, which can be raised and lowered. The dotted lines in the illustration show the high position of this vessel.



The manner in which this arrangement works is as follows: During the charging of the retorts the vessel, which is open on top, and which is covered with a loose cover, is raised by means of a pulley and windless from the working floor to its high position. Consequently the contents of the receptacle flow into the hydraulic main and cause a certain amount of liquid to flow over the edge of the latter and out through the hydraulic main connection. Thus the tarry liquid which is collected during the gasification period is removed. When the receptacle is empty, both arms of the syphon, as well as the rubber hose connection, are full of liquid.

After the retorts have been charged and the lids are closed, the receptacle is lowered until it reaches its lowest position. When this happens the syphon begins to work and a certain amount of liquor is removed from the main, with the result that the end of the pipe no longer dips into the same.

The dimensions of the apparatus are adjusted in such a manner that during the time that the retort is charged an amount of liquid is removed from the hydraulic main, which corresponds to the production of tarry liquid during gasification, with the result that at the end of the discharge period the end of the stand-pipe will always be slightly above the level of the liquid in the main.

SYNTHETIC PETROLEUM FROM WATER GAS

WATER gas is produced from cheap carbonaceous material, the carbon monoxide is converted by catalytic reduction at 230 degrees under atmospheric pressure into methane, which is then decomposed into acetylene and hydrogen in an electric furnace at 2,000 degrees, and the acetylene is converted into a mixture of gaseous and condensable hydrocarbons of the ethylene, cyclic, and naphthene series, by catalytic hydrogenation at 150 to 300 degrees under 0.5 atm. pressure. Peat coke or lignite coke containing 20 per cent of ash (1 kg.) yielded 250 g. of a brown dichroic liquid having a strong smell of petroleum, with d 0.8, calorific value 2,750, and containing 75 per cent of b.p. below 150 degrees. A considerable quantity of the liquid could be sulphonated and oxidised, and it contained aromatic hydrocarbons in quantities comparable to Borneo petroleum.—Chem. Zentr., 1925, 96, II., 114-115.

DISTRIBUTION OF GAS

(Continued from page 260)

gas industry are practically all based on the use of the pressures at the outlet of the governor to actuate a mechanism that opens or closes the supply valve. As the pressure on the outlet tends to lower, the valve is opened, and as the pressure rises the valve tends to close. This automatic action keeps the outlet pressure constant.

Laws Governing Gas Flows

It is perhaps unnecessary to state that gas flows from one point to another because the pressure at one point is higher than that at another, and the law governing this flow of gas is fairly well established. The loss in pressure between the two points is due to the friction of the gas against the walls of the pipe, and the larger the pipe lines and the shorter they are the less is the loss in pressure for a given amount of gas. The usual formula for computing low pressure flow is:

$$\text{Quantity in cu. ft. per hour} = C\sqrt{\frac{d^5\ (p^1 - p^2)}{1 \times w}}$$

Where "d" Inside diameter of pipe in inches.
"p^1" Initial pressure of gas in inches of water column.
"p^2" Terminal pressure of gas in inches of water column.
"1" Length of pipe in yards.
"w" Specific gravity of the gas when air equals 1.
"c" A constant usually taken as 1350.

This formula is used constantly for determining the size of mains which should be laid in a certain district or the size of pipes to be placed in the customer's house, but the formula is seldom computed numerically. A special slide rule or computor is available for this work. This is operated in much the same manner as an ordinary slide rule for multiplying or dividing.

Another Formula

Another formula is used for gas under high pressures. The principle is the same and a computor is also available for the solution of problems without the loss of time. The formula follows:

$$\text{Quantity in cu. ft. per hour} = C\sqrt{\frac{d^5\ (p^1 - p^2)}{1 \times w}}$$

"d" Diameter of pipe in inches.
"p^1" Initial pressure absolute in pounds.
"p^2" Terminal pressure absolute in pounds.
"1" Length of pipe in miles.
"w" Specific gravity of gas.
"c" Constant (usually 33.3).

This formula is used where gas is transmitted at higher pressures and for longer distances.

Use of Formula

It may be advisable to illustrate an application of the first formula. Take 1,000 feet of gas per hour at .65 specific gravity and a length of 200 yards of pipe necessary to supply a large customer or several customers. Trying for 2-inch pipe and solving the equation "$p^1 - p^2$," it is found that this loss in pressure approximates 2 inches of water column, and if the main has an initial pressure of 3½ inches, the pressure at the customers' appliances would then be reduced by friction to only 1½ inches when gas was being used at the rate of 1,000 cu. ft. per hour; but when only half this rate is being consumed the pressure would increase approximately to 3 inches. This means that there would be a variation in the customer's appliances from 1½ to 3 inches. This is too great for good service. It is therefore necessary to consider a pipe of larger size. Trying for a 3-inch pipe, the calculated loss of pressure is found to be .3-inch, which would not be enough to affect the customer's appliances under any conditions; a 4-inch pipe means less than .1-inch loss and a 6-inch pipe .01-inch loss. While a 3-inch pipe in this case may be sufficiently large, it may be advisable to lay a 4-inch pipe, if the connection is located where there may be an increase in consumption later. If the pipe line is buried, the difference in cost between a 2-inch and a 4-inch pipe, while considerable, is a relatively small factor. The expense of digging, especially if the digging requires the breaking and replacing of pavement, and also the difference in the length of life between a 4-inch and a 2-inch pipe, must be considered.

It is possible to design a system for the average situation that would give every one uniform pressure, but the cost of installing such a system would perhaps be double the cost of that ordinarily installed.

High Pressure Formula

Ordinarily in city distribution, especially in a city of small size, the formula for high pressures will not be used very much. But when transporting gas from distant places, as is done with natural gas, or when transporting gas on a high pressure supply line around the city it is necessary to resort to the use of this formula to find the capacity of a line. In the natural gas industry, where it is necessary to change lines so much because of changing field conditions, the engineer would be lost without a slide rule of this type for help in solving rapidly a problem of gas flow. This formula, particularly the value of "c," has been worked out very largely as the result of experiments and operations in the natural gas field.

Problems of Distribution

Probably the review of the growth of a small gas plant may bring to you a better conception of the distribution problems than can be presented in any other way. It will not, of course, be possible to take up many problems which must occur to the distribution engineer, as, for example, where to use cast iron pipe, where to use wrought iron pipe, and, if cast iron pipe is used, what type of joints to use; whether

the governor stations should be built above the ground or in a vault under the street. Brief consideration only can be given to main points in the development.

With a small gas plant there is probably built a small single lift holder. From this plant a small gas main system leads to the center of a small town. As time goes on the town develops, the mains are extended and the gas works increased. Very probably the gas was first sent out from the works without any governor, as the holder pressures were only about 3 inches and the mains were of such size that there was no need of any governors. As the town develops, however, the mains are extended, the plant capacity is increased, and a holder of two or three lifts is erected. It then becomes necessary to install a governor at the works to regulate the pressure, so that when the holder is of a two, three or four-lift, there will always be constant pressure at the outlet of this governor.

Laying New Mains

As the mains extend farther, the problem presented is either that additional mains must be laid from the works, because the small mains that were originally laid would give too great a drop in pressure, or that for a time pressures at the works may be raised during the hours of greatest demand. It is quite common, in small gas works, to increase the pressure on the governor outlet during the hours of heavy consumption in order to get the gas out, even though this gives bad fluctuations on the service pressure to customers near the gas works. In some instances special house governors have been installed for customers near the works, in order to permit the increase of pressures on old lines, thus saving the investment in larger mains for some years.

Large Low Pressure System

Finally, however, a point is reached where increasing the pressure at the holder on the main system, as originally designed, will no longer give satisfactory service. It then becomes necessary either to lay a large low pressure main and thus carry the works pressure out to a farther point without much loss, or to lay a smaller main and carry out gas in this at a higher pressure to empty into the low pressure system at the point most needed. This auxiliary main may empty either through a regulator or by actually keeping a continuous record of the pressure on the delivery end of this main may be kept and the pressure at the works end be maintained at such a point that the delivery pressure remains constant. The choice between the installation of the large main for low pressure or the smaller main for higher pressures would ordinarily be determined by the cost.

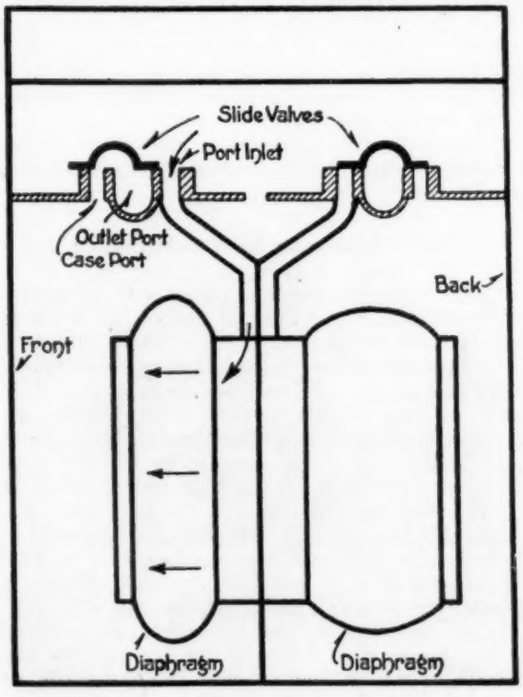
Gas Measuring Devices

In discussing this matter, one of the most important items has not yet been mentioned. This is the meter. There are a number of types of gas meters. Most are familiar with the appearance of the ordinary tin gas meter.

Without going into details it will suffice to state that these meters measure gas by the actual forcing out of a definite quantity of gas by the movement backward and forward of the tin plate on the outside of the diaphragm, and this amount of gas is recorded by a counter which gives cubic feet readings on the dial.

Figure 2 shows diagramatically the operation of the meter mechanism.

These meters are built on exactly the same principle as a steam engine having a cut-off valve and a double cylinder, so that there is no dead center, and it is remarkable with what accuracy these meters run over a long period of years. Year in and year out, the average error of these meters is less than 2 per cent, and it is interesting to know that when they are wrong they usually register against the company; that is, they do not measure all the gas that passes, because the cause of the trouble is prob-



DIAGRAMATIC CROSS SECTION OF COMMON HOUSE METER

Fig. 2—Meter Mechanism

ably the development of a leak in the diaphragm.

In large industrial plants there are sometimes used meters which measure through a proportional valve a definite proportion of the gas flowing through the meter. With these a factor is automatically used, thereby giving a reading of all the gas that passes through, whereas only about 1 per cent is actually measured. This is known as a proportional meter.

Again, when measuring gas to this class of customer, there is very frequently used an orifice meter which measures the speed of gas through an orifice. From this speed the amount of gas that has passed is calculated.

REGULATING THERMAL VALUE OF GAS

(Continued from page 262)

ployed. This should be fairly high, about 80 millimeters.

It is possible to employ the instrument as an indicator of operating conditions in the plant. When this is done the air inlets are so regualted that the apex of the inner cone just touches the magnesia rod, as shown in the figure. Then, if it happens that at any time the apex of the inner cone is lowered and the rod remains perfectly incandescent, notwithstanding, it is an indication that the thermal quality of the gas has deteriorated. What has happened is that the quantity of air that has been admitted into the burner has become too great. That is, there is too much air present in the air-gas mixture, more than is required to effect complete combustion of the combustible ingredients of the gas. This, of course, has the result of shortening the length of the flame. Then, when the height of the inner blue cone is raised, the hottest portion of the flame does not come in contact with the magnesia rod and, on the other hand, the rod is found in a position where the temperature is comparatively low. The result, then, is that a dark spot is formed on the magnesia rod.

Using Apparatus as a Calorimeter

But it is also possible to employ the apparatus as a sort of calorimeter. The air openings are set in a certain definite manner and the position of the collar, c, on the graduated thread is noted and read off in units and tenths. Then the calorimetric value of th gaseous fuel is determined. For example, it is found that the position of the collar, b, is 3.5 for this gas, corresponding to a position of the air valves which gives a flame, the inner blue cone of which will touch the magnesia rod at exactly its apex. Then it is possible to calibrate the scale in terms of calorimetric value, and when any other kind of gas is being examined it is possible to read off the approximate calorimetric value of the gas by regulating the air openings so that sufficient air is admixed with the gas to give a flame, the apex of the inner blue cone of which just touches the magnesia rod. The position of the collar, b, is read off the scale and the corresponding calorific value of the gas may be readily determined from a table.

The Principles Involved

It is assumed that any given combustion value will always have a corresponding constant density and a constant rate of flame propagation. Therefore, in a burner of the sort just described, this gas, when burned under conditions of constant gas pressure, constant humidity and temperature of the air, will always require the admission of the same quantity of air in order to give a flame, the apex of whose inner blue cone just reaches the magnesia rod. This is the underlying principle upon which the measurement is made.

Of course, the practical value of the apparatus depends on the magnitude of the error that is entailed in its use. Of course, errors can arise from variation in any of the constants that have been mentioned above. This applies to variation in the density of the gas, in the rate of flame propagation, in the temperature and degree of humidity possessed by the air that is admixed with the gas. Thus it is seen that the errors are based on the one hand on the change that may take place in the properties of the gas and, on the other hand, on that which may ensue in the properties of the air used for burning the gas.

Variation in Density and Rate of Flame Propagation

On the face of it, it is evident that the two variations which refer to the properties of the gas are more apt to affect the accuracy of the instrument than those that are concerned with the air used for combustion. Both calculation and experimentation, on the other hand, have shown that this variation or error is not as great as it appears at the outset.

For example, it was assumed that there was a drop of 1 per cent in the density of the gas. This gave rise to an increase in the gaseous volume which amounted to half a per cent, and an increase of one-tenth of a per cent in the volume of the mixture of gas and air, which is supplied to the burner. But it remains that the weight of air that is taken in is always constant, and, as the temperature does not vary, the volume remains constant as well. The result is that the ratio of the volume of air which is drawn into the burner to the volume of air which is required to effect complete combustion is reduced by half of a per cent. It was found that this reduction and the increase of one-tenth of a per cent in the total volume of air and gas introduced into the burner will not change the height of the inner blue cone in the flame of burning gas to such a degree which will be recognizable by the eye.

Effect of Carbon Monoxide on Rate of Flame Propagation

Experiments have been made to determine the influence of carbon monoxide on the rate of flame propagation. Results have shown that the rate of flame propagation varies by about 20 per cent between a carbon monoxide content of 7 per cent and 18 per cent. It thus follows that this increase from 7 to 18 per cent is not possible unless it is accompanied by a corresponding increase in the combustion value of the gas to the extent of more than 20 per cent. It is, of course, evident that when the gas works is operated properly in order to manufacture a gas with a constant heating value, as is required in almost any community, it is quite impossible to have a variation in the thermal value of the gas that is as high as 20 per cent. It thus follows that it is rather improbable that the variations in the rate of flame propagation of the gas, as it is being manufactured from day to day, can have any material effect on the accuracy of this instrument when it is used as a calorimeter, that is, when it is employed to ascertain quickly and approximately the calorific value of the manufactured gas. The thermal value

of the gas remains constant during the manufacturing period, or else varies slightly around an average point and under such conditions any change that does take place in the composition of the gas, while it will affect to some degree the rate of flame propagation, is not sufficiently high to negate the value of the results that are obtained with this instrument. The net conclusion to be drawn, then, is that the instrument can be depended upon to give reliable results, when the temperature of the air and the percentage of moisture contained in it do not vary at all or only within small limits.

Temperature and Humidity Variations

However, it is a fact that the temperature and the humidity of the air will vary, not only from day to day, but from hour to hour, and such variation is bound to have an effect on the results that are obtained with this instrument. When the advisability of compiling a set of correction factors was broached it was determined after study that it would be impossible to establish such a set of factors that would apply to all instruments, for the simple reason that the dimensions and characteristics of the instruments are bound to vary. It was thought best to determine the necessary correction every time the atmospheric conditions changed to a marked degree. This can, of course, be done with the aid of a regular calorimeter. The value of the instrument is materially reduced by this fact, but, as pointed out in the original article, this instrument is not intended in any way to serve as a substitute for the regular calorimeter, but merely as an auxiliary to the same.

YOUNG MEN AND THE UTILITY BUSINESS

(Continued from page 261)

to provide additional plant and equipment for taking care of increased demand for your product.

Business Essential to Country's Upbuilding

More than 200,000 men and women from all walks of life have invested the results of their thrift in the companies with which I have something to do. These companies supply one form or another of public utility service—mostly electricity and gas—to more than 2,500,000 customers, disregarding some 220,000,000 riders yearly on electric railways. It is some responsibility—and the responsibility has to be shared by my assistants all the way down the line—to be charged wth seeing to it that good service at reasonable rates is supplied to those millions of customers, and that 200,000 investors shall receive at the same time a fair return on the money they have put into the businesses which we operate for them. But the responsibility is not all burden; there is stimulation and inspiration in it.

Advancement in Efficiency Remarkable

One company of which I have knowledge represents the consolidation or absorption of 120 small isolated enterprises. The most efficient of the plants thus acquired used to burn eight pounds of coal to produce one kilowatt-hour of energy; their average consumption was twelve pounds per kilowatt-hour. The consolidated company's average consumption is about two pounds of coal per kilowatt-hour of energy produced. If the former 120 separate enterprises were still running and generating as much energy today as the one company is, they would be burning up each year 2,000,000 tons of coal more than the one company is using. That is conservation of natural resources, and it is going on all over the country.

"Holding" Companies Facilitate Growth

The investment or "holding" company acquires an interest in the securities of various local companies within a given area, mostly their junior securities. It is not necessarily a majority interest, but is sufficient to insure a dominating voice in the affairs of the local companies. The investment or "holding" company then applies, in each local com-

The Blue Flame of Convenience
Cubic feet of gas—round figures of "price"—a few rules and regulations; that, in what you see, in a hurried way, in your monthly gas bill.
But cold facts like these do not tell half the story!
Gas Service is human Service, guarding the health, happiness and welfare of your family, ensuring perfectly cooked meals, instant hot water flowing at the faucets, warm comfortable rooms, a wash-day with clothes washed, dried and ironed, and kitchen refuse disposed of in a sanitary way.
But still to be included are the human hands, engineering brains, the costly maintenance of huge structures of steel and iron, extensive networks of mains, valves and pipes, coal, coke and oil reserves, an office staff and other essential links in a great organization chain built for your benefit.
If you would know the real story told by your monthly Gas Bill; if you would fully appreciate the blue flame of convenience that comes into your home, you must think of all these factors.
The Bridgeton Gas Light Co.

In an Effort to Explain Gas Service

pany's affairs, the resources and experience of larger enterprises.

When a local company needs capital for additions to plant and equipment, the investment company sees to the financing on better terms than the local company could command. It furnishes expert engineering service of a quality the local company could not afford. It masses the purchasing requirements of many subsidiaries and so saves money for all of them. It places at the service of the smallest local operating company in its group all of the managerial experience and ability acquired in immensely larger fields. If there is a "weak sister" in the group, losing money for the investors in it, and giving poor service, it is nursed along until it becomes self-supporting.

Small Communities Get Big Benefits

There are many examples of how this has worked out in practice. Small communities, hitherto served inefficiently or not at all, get good service at reasonable rates because many small and inefficient plants have been displaced by large generating stations, advantageously located and economical in operation. Energy thus produced is distributed to the smaller communities, which could not support individual plants, by means of high tension transmission lines. This suggests, in passing, the undue emphasis usually put upon the matter of rates in discussions of public utility service. A cent or two, more or less, in electric rates, is of comparatively slight importance to those little towns and villages which are now getting full 24-hour service, in comparison with having otherwise only part-time service or none at all.

Gas Development Possibilities Are Alluring

Gas is only just beginning to come into its own as a servant of industry as well as of the home. The possibilities of general house heating by means of gas, of applying gas to the thousand and one heating processes of manufacturing and fabrication, of manufacturing gas in large central plants and transmitting it considerable distances much as electrical energy is now transmitted—these have only been barely sensed, much less realized.

There are economies and efficiencies to be developed in the manufacture of gas that should be an almost irresistible lure to the scientifically inquiring mind. Some technicians go so far as to say that burning raw coal to produce heat or any other form of energy is criminal waste. Roughly speaking, one ton of gas coal, under present methods, will yield about 10,000 cubic feet of gas, 1,400 pounds of coke, 25 pounds of ammonium sulphate (an essential component of farm fertilizers), 1.5 gallons of benzol and 9 gallons of tar. The 10,000 cubic feet of gas will do as much cooking as the ton of coal would in the average coal range, and leave all of the coke, ammonium sulphate, benzol and tar as clear gain.

Then there is the question of the low temperature distillation of coal, the recovery of the by-products, while still preserving most of the fuel for the production of electrical energy.

Smokeless Cities

When these possibilities are fully developed, natural fuel resources will be immensely conserved, and our cities will be converted into smokeless towns, where the inhabitants will no longer have their offices and homes and furnishings defiled, and their health impaired, by the products of inefficient combustion carried in the air. There is great advance possible in making Illinois coal more available for gas-making purposes, and in developing more flexibility, and consequently more efficiency and economy, in the heating value standards applied by state commissions or other regulatory bodies.

Opportunities Widely Vary

The opportunities are not exclusively for men trained in the scientific or technical courses of this and similar institutions of learning. If you are specializing in accounting, in business administration, or in public and industral relations, or if you want to sell stocks and bonds and merchandise, our industry surpasses any other that I know of in what it has to offer for the future. Nor indeed are the openings created by the public utility industry confined to service in the industry itself. If you are going into manufacturing, or some other industrial or commercial line, you are quite likely to find that some branch of the public utility business is among the best customers of that business. You will then find it an advantage to know something about the public utility business. It is easiest to sell goods to one whose business you understand, and to whom you can talk intelligently in his own language about the use to be made of your merchandise in his business.

Note of Warning

In connection with my enthusiasm on this subject, perhaps a warning note may not be out of place. It is that you do not come from college to us or to any other business expecting too much at the beginning. You will not be made executives while fresh from the class room or lecture hall. No amount of university education can take the place of practical experience in business or industry. You will have to go through a considerable period of probation. The manner in which you go through it, the way in which you stick to the job even when you think you are not getting along as fast as your college "sheepskin" should carry you, will be a big factor in determining your ultimate success.

SAFETY DEVICES FOR TANK WATER HEATER

(Continued from page 264)

Use of Relief Valve

There may be some local ordinances which call for a relief valve to be placed on all pressure jobs. This would appear to indicate that an element of danger is recognized when a closed system is used.

As to what constitutes a proper relief valve is a question for much discussion. We ordinarily speak of a relief valve as a valve to relieve excessive pressure.

But of what value are pressure relief valves?

A pressure relief valve is a valve so constructed that when the pressure increases to an amount above which the valve is set, the valve will be forced off its seat by the increase of the pressure and prevent the pressure from increasing further to the point of danger. We all know from experience that the ordinary type of pressure relief valve cannot be depended upon as a positive means of safety.

Water not subjected to pressure above the atmospheric, will turn to steam at 212 deg. Fahrenheit. That is, if you heat water in the open to 212 deg. it will turn to steam. When you subject the water to pressure, you raise the temperature at which it will turn to steam. For instance, when water is subjected to 40-lbs. pressure it will not turn to steam until it reaches 286 deg. Fahrenheit. When water turns to steam it increases its bulk about seventeen hundred times.

Steaming Point of Water

Below is given the steaming point of water under different pressures:

1-pound	215-degrees
5- "	228- "
10- "	240- "
15- "	250- "
20- "	259- "
25- "	267- "
30- "	274- "
35- "	281- "
40- "	287- "
45- "	292- "
50- "	298- "
60- "	307- "
70- "	316- "
80- "	324- "
90- "	332- "
100- "	338- "
110- "	342- "
120- "	350- "
130- "	356- "

The demand of later years has been for more hot water in shorter time. To meet this demand the manufacturers of water heating appliances have increased the heating power of their appliances and these powerful heaters are being attached to boilers that were formerly heated by less powerful heaters.

Heating Water Quickly and Safely

There is a way to meet the demand for quicker hot water service and at the same time provide means for safeguarding against possible trouble from high temperatures or excessive pressures.

Let us suppose that a customer has a direct pressure installation with a water heater and check valve on the supply line; there is a 30-gal. boiler in use with a soldered bottom and a water pressure on the street is 80 lbs. Therefore, that water can be heated to 324 deg. before it makes steam. The softening point of solder is about 320 deg. You can readily see that in this case any weak point in the solder would break away before the water reached the temperature of 324 deg. and if the solder does break it results in the pressure being reduced to atmospheric with the resultant consequence of the water expanding seventeen hundred times and sending the boiler flying in the air.

Therefore, the answer to the question, "Why are safety devices necessary on tank water heaters," is that safety devices are necessary on tank heaters to prevent the overheating of the water.

What Devices May Be Used?

In the above description you can readily see that pressure relief valves of the type that function when the pressure increases a given amount above that at which the valve is set, would not prevent the water becoming overheated and, therefore, boiler explosions of the type described above may occur with a perfectly good pressure relief valve in use. Aside from this fact it is also true that all types of pressure relief valves are subject to sticking and becoming inoperative due to the valve freezing or corroding while on its seat.

You will agree that it would be unwise and unsafe to depend on the average householder to provide the means of safety by operating the valve occasionally. When these valves are placed over the sink or wash-trough the valve is very apt to be tampered with and rendered useless as a means of safety. Should there be a pressure relief valve installed and should the valve really operate, water would be spilled on the floor when this happened, the man of the house would probably place a flat-iron or weight on the lever to keep the valve closed.

Therefore, with this brief argument against the use of pressure relief valves it should be remembered that a pressure relief valve is not in itself a means of safety. What is needed is some appliance to prevent the water from becoming overheated.

Three Satisfactory Appliances

There are at least three satisfactory appliances in use today which serve the purpose of preventing the water in the boiler from being overheated and thereby preventing serious trouble.

1. Thermostats.
2. Smith relief valves.
3. Donnelly relief valves.

There are three types of thermostats: first, the graduating thermostat; second, the graduating thermostat with combination levers which increase the speed at which the gas valve opens and closes; third, the quick acting or snap thermostat.

All thermostats are built on the old principle of expansion and contraction. Usually a copper tube is used with a closed end, inside of which is placed a carbon or porcelain rod of some material which expands and contracts to a lesser degree than copper. The difference in the expansion and contraction of these two materials causes the gas valve to open and close.

If a thermostat is simply to prevent the overheating of the water, the low-priced common thermostat answers the question admirably because its whole mission is simply to shut the gas down so it can do no harm.

Smith Relief Valve

The Smith relief valve is a valve which has two fusible plugs in contact with the water, one fusible plug melting at between 212 and 220 deg. and the other plug melting between 240 and 250 deg. The idea of the fusible plugs being at different temperatures is that if one plug did fail to function or if the water became unduly hot even after the first plug had functioned that the second plug would come to the rescue and make the necessary relief. The Smith relief valve also is constructed to relieve excessive pressure by a valve being forced off its seat, thereby relieving the excessive pressure, so that it can be called a "combination pressure and temperature valve." It is a very practical valve, sells at a moderate price and is used extensively for all boiler installations where the system is closed.

Donnelly Relief Valve

The Donnelly relief valve is of a type very similar to the Smith relief valve except that it has one fusible plug melting at about 243 deg.

There is a state law in Massachusetts which states that a boiler may not be used on a pressure exceeding 42½ per cent of its cold water test pressure. This would mean that a boiler tested to 200 lbs. cold water pressure could not be used on a water pressure exceeding 85 lbs. Therefore, if it is desired to use relief valves of these types, it is not necessary to have them set at many different pressures for the following reason:

You will find that most boilers in use have been tested to 200-lb., 250-lb. or 300-lb. cold water pressure. The 200-lb. boiler can be used on pressures not exceeding 85 lbs.; the 250-lb. boiler can be used on pressures not exceeding 106 lbs., and the 300-lb. boiler can be used on pressures not to exceed 127 lbs.

All that is necessary, therefore, is to have three different pressures for the relief valves, each set 10 or 15 lbs. in excess of the above mentioned pressure, or 100 lbs., 121 lbs. and 142 lbs.

Where Shall They Be Located?

It is recommended by the manufacturer of the Smith relief valve that it be placed on the hot water line just above the boiler, but we have found that unless the valve is placed on a spur line some little distance from the hot water line, that the fusible plug will melt sooner than is required to prevent danger.

It is not always possible to run a spur pipe for the valve due to the boiler being in a closet or in a small space. We are now placing it on the cold water supply line to the boiler as recommended by our local town plumbing inspector. A tee is cut into the cold water supply line and the valve is screwed into this tee. In this location the fusible plug would not melt until the entire amount of water in the boiler had heated back into the cold water supply line where the valve is placed.

The Donnelly valve is placed on the hot water line running from the boiler and the fuse in this valve is not affected by the hot water passing from the boiler to the faucet until it reaches its melting point of 243 deg.

The graduating thermostatic valve is usually placed at the range connection outlet on the side of the boiler and if this is in use a boiler coupling may be cut into the boiler where desired and the valve placed on this coupling.

PITTSBURGH'S YEARLY CONSUMPTION 50 BILLION CUBIC FEET

Greater Pittsburgh's industries use as much as fifty billion cubic feet of natural gas in a single year, according to the Pennsylvania Public Service Information Committee. That, it is estimated, would be equivalent to more than 3,000,000 tons of coal.

The total investment in the natural gas industry in the United States is $1,500,000,000. A careful check-up discolses that the users of natural gas number 15,000,000. There are 41,000 gas wells in operation and 15,000,000 acres under lease.

Many industries are located in the Pittsburgh District on account of available natural gas, which, together with the abundant coal resources, has helped to make Western Pennsylvania the greatest producing district in the world.

In 1821, the first gas well in the United States was drilled near Fredonia, N. Y. In 1840, the first gas well in Pennsylvania was drilled near Centerville, Butler County. The well was drilled to a depth of only 700 feet. The usual depth now are 2,500 to 3,000 feet. Several recent wells have exceeded 7,000 feet in depth.

According to the United States Geological Survey data for 1923, the latest information available, twenty-five states produced natural gas. The most important states were West Virginia, Oklahoma, California, Pennsylvania and Louisiana. The principal consuming states, in the order of volume of natural gas consumed were Oklahoma, Pennsylvania, California, Ohio and Louisiana.